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POWER WASHING METHOD AND APPARATUS

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No. OF CLAIMS 5

The present invention relates to power washing method and apparatus adapted for industrial applications for cleaning various manufactured articles. This invention is described as embodied in a machine for high-pressure washing, rinsing and drying of metal parts, for example, such as crankshafts and camshafts of internal combustion engines.

In the particular method and apparatus described herein, the articles to be washed are supported on a continuous conveyor belt and intermittently advanced along a path passing in succession through a power washing stage, a power rinsing stage and a power drying stage. Each of these stages includes one or more stations wherein high-pressure jets of fluid are directed at various predetermined areas on the outside or inside of the article. The intermittent motion of the conveyor stops the articles in succession in accurate alignment with every station, thus providing efficient high quality cleaning.

In many mass-producing type industrial applications involving the fabrication of complicated machined parts and assemblies, it is necessary at one or more points in the production schedule to remove the various soils which adhere to the surfaces of the articles and accumulate as a result of the previous manufacturing and fabrication steps.

The method and apparatus described herein are particularly well suited for the cleaning of crankshafts, camshafts and the like, and of many other types of parts having bearing surfaces or other complex surfaces or cavities which must be thoroughly cleaned. It is important that

bearing surfaces and all other portions of the parts be thoroughly cleaned of all soils to prevent damage when the parts are assembled and run. The thorough cleaning of close tolerance parts enables their dimensions to be tested with precision. In many cases, the presence of soils on these precision parts cause erroneous readings of their dimensions, resulting in the rejection of parts which do not actually lie outside of the permissible tolerance range, or vice versa.

Among the many advantages of the present invention are those resulting from the fact that the high-pressure washing and rinsing jets are directed at predetermined angles. The article to be washed is held for a brief period at every station, with particular areas of the article arranged to intercept certain ones of these jets at each station at the angle which produces maximum cleaning action by the impinging streams. Thus, quick complete cleaning of selected areas of the article is obtained at each station and the article can be advanced rapidly from station to station.

As a result, a large number of articles can be cleaned in a short period. Moreover, because of the efficiency of the cleaning operation as described, the apparatus is compact and lends itself to efficient mass production operations.

The various aspects, features, and advantages of the present invention will be more fully understood from the following description considered in conjunction with the accompanying drawings, in which:

Figure 1 is a side elevational view, partially

diagrammatic, showing a machine embodying the method and apparatus of the present invention for washing automobile engine crankshafts and camshafts, the near side of the machine is omitted to show the arrangement of the various parts;

Figure 2 is a cross-sectional view taken along the line 2-2 in Figure 1 looking to the right and showing, on enlarged scale, the arrangement of the high-pressure spray nozzles in one of the washing stations of the machine in Figure 1 with a crankshaft in indexed position in this washing station;

Figure 3 is a top view, taken along the line 3-3 of Figure 1, showing a short section of the conveyor used in the machine and showing portions of the chain drive sprocket wheels at the right end of the machine;

Figure 3A is a sectional view taken in the region 3a of Figure 3 looking into the plane of the drawing, showing the way that the cross member 22 is removably secured tc the chain;

Figure 4 is a side view, partially in section, taken along the line 4-4 of Figure 3 looking to the right and showing one of the jigs for holding one end of a crankshaft;

Figure 5 is a side view, partially in section, taken along the line 5-5 of Figure 3 looking to the right and showing the jig for holding the other end of the crankshaft;

Figure 6 is a side view of the indexing mechanism used to advance the conveyor chain, this view being taken along the line 6-6 looking to the left in Figure 3; and

Figure 7 is an enlarged side view of one of the adjustable high-pressure spray nozzles used in the washing and rinsing stations of the machine in Figure 1.

In the machine as shown in Figure 1, the crankshafts 12 to be cleaned are transferred in sequence from a production line at the left of the machine (not shown) onto pairs of holding jigs 14 which are arranged near opposite sides of a continuous conveyor 16 so as to support the crankshafts horizontally and extending across the conveyor from side to side, as seen in Figure 2. This conveyor 16 comprises a pair of spaced parallel chains 18, as seen in Figure 3, with a plurality of removable frames 20 extending between the chains at every fourth link, each frame including a cross bar 22 with one of the holding jigs 14 on the top side near each end, as described in detail below.

The chains 18 pass up around a pair of large idler sprockets 24 at the left of the machine which guide the conveyor into the machine where it is pulled to the right by means of a pair of drive sprockets 26. The conveyor 16 passes in succession through a power washing stage 28, a power rinsing stage 30, and a power drying stage 32 and then exists from the machine near the drive sprockets 26, the cleaned crankshafts then being removed from the jigs 14 and passed in sequence to the next production step. The empty conveyor 16 returns under the machine past a number of smaller idler sprockets 33 with the chains 18 running along supporting guide tracks 34 formed by angle irons extending longitudinally of the machine underneath it.

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In each stage are a number of separate stations wherein particular areas of the crankshafts are subjected to high speed streams of fluid. The conveyor 16 is advanced intermittently through the machine with each pair of jigs 14 pausing briefly in each station in succession. A partition 36 with a small door 37 for the conveyor and crankshaft separates the stages 28 and 30, and a similar partition 38 with a door 39 separates the stages 30 and 32.

At the bottom and extending off to one side (see also Figure 2) of the washing stage 28 is a tank 38 holding washing liquid, indicated at 40. This solution is sucked into the bottom of a two-stage centrifugal pump 41 and forced out of the upper stage 42 at extremely high pressure through pipes 43 and a pair of manifolds 44 extending along parallel to the chains 18. Connected to the manifolds 44 are a plurality of transverse pipes 46, some extending across the machine above the conveyor 16 and others below the conveyer. Each of these transverse pipes 46 includes several openings over each of which are clamped adjustable spray nozzles 48 and jet nozzles 50 described in detail hereinafter. These nozzles 48 and 50 are arranged to direct a high speed spray or stream, respectively, of washing solution at various predetermined areas of each crankshaft, as they pause in each station. The pump 41 is supported by a bracket 52 from the top 53 of the side extension of the tank. The pump has a vertical shaft 54 extending up in a housing 56 through a bearing 58 to sheaves 60 driven by V-belts from a suitable electric motor 62. A suitable high pressure two-stage centrifugal pump for use

in the machine 10 is described in detail and claimed in our copending Canadian patent application, Serial No. 694,104 filed October 5, 1955.

As indicated in Figures 1 and 2, the adjustable nozzles 48 are aimed at various specific areas of the crankshaft. A pair of these nozzles 64 and 66 are aimed at opposite ends of the crankshaft to squirt streams of washing solution into the passages in the interior of the crankshaft, to thoroughly clean it. Thus, advantageously, every facet of the crankshaft receives in turn a thorough high pressure washing with the washing solution in each case impinging on the various crankshaft surfaces at the optimum cleaning angles, enabling the cleansing to be done in a brief time.

The partition 36 keeps the washing solution from entering the rinse stage, and, if desired, a flexible curtain may be hung in the door 37 to provide further isolation. As shown in Figure 1, the rinse stage may be substantially identical with the washing stage and parts in the rinse stage performing corresponding functions are indicated with corresponding reference numerals followed by the suffix "a".

After leaving the rinse stage 30 the jigs 14 pass through the drying stage 32 wherein the crankshafts 12 are dried by air drawn in through a steam-heated radiator 64 and driven by a pump 66 into a manifold 68 connected to various hot air nozzles 69. A pair of these hot air nozzles 70 are directed at the opposite ends of the crankshaft in the last station 35 to dry out their internal passages. The connection to the steam pipes in the radiator 64 is made by pipes 72. As shown in Figure 1, a plurality of the hot air nozzles in one station are aimed so as to converge downwardly toward a part being dried in that station, and other nozzles are aimed upwardly toward parts in other stations being dried, thus effecting complete drying of the cleaned parts.

As shown in Figure 3a, the spaced chains 18 of the conveyor include links 73 and cross pins 74 surrounded by rollers 76. The inner ends of the cross pins 74 are headed, and their outer ends are held by cotter pins 78. The drive sprocket 26 has teeth 27 (Figure 3) adapted to engage every other space in the chains 18.

The frames 20 are removably secured between every fourth link of the chains 18. As shown in Figure 3a, each end of the cross members 22 has a bracket 82 extending at right angles to the member 22 and resting against one of the links 73, and being somewhat wider than the link. A pair of indentations 84 are formed in the outer face of each bracket 82 spaced a distance apart corresponding to the spacing of the heads of two adjacent cross pins 74. Intermediate these indentations 84 is a hole 86 arranged to fit a bolt 88 which extends across through holes in the centers of the two adjacent links 73 and clamps the bracket against the inner link 73. A sleeve 89 surrounds the bolt 88 between the links 73. Thus, advantageously, the frames 20 are enabled to be slid into place between the two chains and clamped in place by only two bolts, being oriented by engagement of the heads of the cross pins 74 with the indentations 84 in the brackets.

Shown in Figures 3 and 6 is the indexing mechanism 90 to index the conveyor 16 through the machine 10. This indexing mechanism includes a ratchet wheel 92 rigidly secured to a rotatable shaft 94 which turns the drive sprockets 26. The ratchet wheel 92 has four equally spaced teeth 96, each with a radial face 98 facing clockwise as seen in Figure 6.

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In order to turn the ratchet wheel 92, a drive arm 100 is swingably mounted on the shaft 92. The arm 100 comprises a pair of parallel spaced plates, as seen in Figure 3, which straddle the ratchet wheel 92. Engaging the teeth 96 is a pawl 102 having one end pivotally secured between the plates of the drive arm, with its free end biased by a spring 104 thrusting against an abutment 106. The drive arm 100 is swung back and forth, as indicated by the arrow 108 in Figure 6, by means of a piston rod 110 pivoted at its free end and a pneumatic cylinder 112 supported by means of trunions 114 on the frame of the machine 10.

To advance the conveyor 16, air under high pressure is introduced from a control unit 116 through a flexible hose 118 into the lower portion of the cylinder 112 driving a piston (not shown) within the cylinder up, swinging the arm 100 counterclockwise around the shaft 94, engaging the pawl 102 with a face 98 and turning the ratchet wheel 92 and shaft 94.

In order to enable precise positioning of the jigs 14 at the various stations 35, a stop detent 120 is pivotally mounted on a shaft 122 carried by an adjustable bracket 124. The stop detent is arranged to engage radial faces 126 of a stop ratchet wheel 128 to stop the conveyor belt 16 in the desired positions. The wheel 128 is similar to the wheel 92 and is rigidly secured to the shaft 94, but with its radial faces turned counterclockwise about the shaft 94 to face the free end of the detent 120. The detent bracket 124 is secured by bolts 130 to the machine frame, and is adjusted in position by means of adjustable horizontal bolts 132 (please see Figure 6) so as precisely to align the jigs 14 in the stations 35 at the end of each stroke of the arm 100.

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Secured to the machine frame near the terminal position of the outer end of the arm 100 is a control switch 134 which is struck by an adjustable stop 136. The switch 134 is connected by a wire 139 to the air control unit 116 and causes the air supply to be shut off from the hose 118 and turned on in a hose 138 connected to the upper end of the cylinder 112 to return the arm 100 to its initial position in readiness for the next indexing operation.

In order to lift the detent 120 from engagement with a face 126 of the stop ratchet wheel 128 prior to the beginning of each indexing operation, a shoulder 140 is provided at one side of the detent 120. This shoulder is engaged by a cam arm surface 142' near the inner end of one of the plates of the arm 100. As the free end of the arm 100 swings back in a clockwise direction, the cam 142 rises up under the shoulder 140 and lifts the detent 120 out of engagement with the stop ratchet wheel. Also, the free end of arm 100 activates a switch 135 which is connected by a wire 137 to air control unit 116 for initiating the next stroke of the piston 110.

During the next stroke when the arm 100 again moves clockwise, the cam 142 swings down and allows the detent 120 to drop down into engagement with the stop ratchet wheel.

As shown in Figure 2, as the chains 18 pass through the machine 10 they are supported by tracks 143 formed by angle irons extending longitudinally through the machine 10. The ends of these tracks 143 extend out near the large sprockets 24 and 26 at each end.

In case there is an inadvertent delay in unloading

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the crankshafts 12 at the discharge end of the machine, a lever 144, with its free end inclined and in position to be depressed by the end of a crankshaft, is connected to a switch 146. The switch 146 is connected electrically by a cable 147 to the air control unit 116 and shuts off the air supply from the hose 118, stopping any further indexing until the cranksahft on the lever 144 is unloaded.

Any fumes in the chambers 28 and 30 are removed through ducts 148 by an exhaust fan 149 above the machine.

In Figure 7 is shown, on considerably enlarged scale, a cross-sectional view of one of the adjustable spray nozzles 48 clamped in position on a pipe 46, shown in cross section. A large hole 150 is drilled in the pipe 46 and arranged to face in the general direction toward which the spray or stream of high speed fluid is intended to go.

The adjustable nozzle includes a generally C-shaped clamp having one end 152 with a surface broad enough to cover the hole 150. A smaller orifice 154 extends through the end 152 of the clamp and is over the larger hole 150 in the pipe 46. The opposite end 155 of the C-shaped clamp has an adjustable clamping bolt 156. The stream of fluid issuing from the small orifice 154 passes a bullet-shaped director 158 supported by arms 160 from the end 152 and advantageously is broken into a high-speed spray.

The adjustable nozzles 50 are generally similar to the adjustable nozzles 48 except that in place of the

orifice 154 and the director 158, a small pipe (as shown in Figure 2) is secured to the arm 152. The inside diameter of this pipe is smaller than the diameter of the hole 150 in the pipe 46 to enable the angular adjustment of the nozzles 50 over a considerable angular range.

As shown in Figures 4 and 5 the crankshaft supporting jigs 14 on the cross members 22 are generally U-shaped in outline, having arms 161 and 162. The arms 161 and 162 have inner surfaces 163 and 164, respectively, which define a J-shape, the surface 163 is straight and the surface 164 is arcuate so as to support the crankshafts 12 without engaging any of their machined bearing surfaces, thus, advantageously leaving them all completely exposed for efficient thorough cleaning.

The straight surface portion 163 engages a crank arm 166 of the crankshaft off to one side of its associated connecting rod bearing surface. Into the arcuate surface 164 nests one of the counterweights 168 of the crankshaft. As shown, the pair of jigs on each cross member 22 are in reversed position with respect to each other, for they are preferably spaced apart far enough on the cross members 22, as seen in Figure 2, so as to engage the two counterweights and the outer sides of the two crank arms at opposite ends of the crankshafts 12. In order to prevent the crankshafts from sliding crosswise in the jigs 14, U-shaped brackets 170 are secured to at least one of the arms 162 of each pair of jigs. The ends 172 of the bracket 170 point in toward the space above the jig arms 161 and 162 and embrace opposite sides of one of the end counterweights on each crankshaft.

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It will be understood that liquid level controls may be used in the tanks and that steam or electric units may be used for heating the wash and rinse liquids. Also, sludge removal apparatus and access openings (not shown into the tanks are provided to enable their cleaning.

The positioned washing, rinsing, and drying which is obtained by the method and apparatus described is highly advantageous for any interference between the various liquid streams is avoided so that each stream at each station acts at maximum efficiency in cleaning and drying the assigned area of the article being cleaned.

From the foregoing description it will be understood that the power washing method and apparatus of the present invention are well adapted to provide the many advantages discussed above, and that they can be adapted to a wide variety of industrial washing and cleansing operations and that various changes or modifications may be made therein, each as may be best suited to a particular application, and that the scope of the present invention, as defined by the following claims, is intended to include such modifications or adaptations limited only by the prior art.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Power washing apparatus for cleaning complex manufactured parts such as engine and machine parts and the like comprising a machine frame having a plurality of stages including a power washing stage and a power drying stage, each of said stages including a plurality of stations, intermittently operating mechanism adapted to advance each part from station-to-station through said stages while retaining the part for brief periods in predetermined positions in each of said stations, a reservoir for cleaning fluid in said power washing stage, pump mechanism communicating with said reservoir, a plurality of nozzles in each washing station, said nozzles being directed toward a specific predetermined area of the part as it remains stationary in the station so that the entire part is washed as it passes through the successive stations of said washing stage, an air blower in said power drying stage, an air manifold connected to the output of said blower, a plurality of air nozzles in said power drying stage connected to said manifold, said air nozzles being directed toward predetermined areas of the part as it remains stationary in the respective stations of said power drying stage, and air heating means for heating the air being supplied to said air nozzles.

2. Power washing apparatus according to claim 1 wherein the specific predetermined area of the part at each station is different.

3. Power washing apparatus according to claim 1 wherein the air nozzles at each station in said drying stage are directed toward a specific predetermined area of the part at that station so that the entire part is dried as it passes through the successive stations of said drying stage.

4. Power washing apparatus comprising a machine frame, a plurality of uniformly spaced washing stations on said frame, a pair of parallel continuous uniformly spaced chains supported to move past said stations, each of said chains including links extending longitudinally of the chain and cross pins

passing therethrough, said cross pins projecting beyond the outer surfaces of at least some of said links, a plurality of removable uniformly spaced conveyor frames extending between said chains, each of said frames comprising a cross member extending between and perpendicular to said chains, a pair of parallel brackets extending perpendicularly to opposite ends of said cross member with the outer face of each bracket being adjacent to a link of one of said chains, each of said brackets having a hole therethrough perpendicular to its outer face, and a removable fastening extending through said hole and engaging the adjacent link, each of said brackets having a recess in its outer face fitting over the projecting end of one of said cross pins and holding the bracket in alignment with the adjacent link.

5. Power washing apparatus as claimed in claim 4 and wherein the outer face of each bracket has a pair of indentations on opposite sides of its hole and spaced apart a distance corresponding to the spacing of the cross pins and engaging the ends of the respective cross pins of the adjacent link, with said removable fastening engaging said adjacent link between its respective cross pins.

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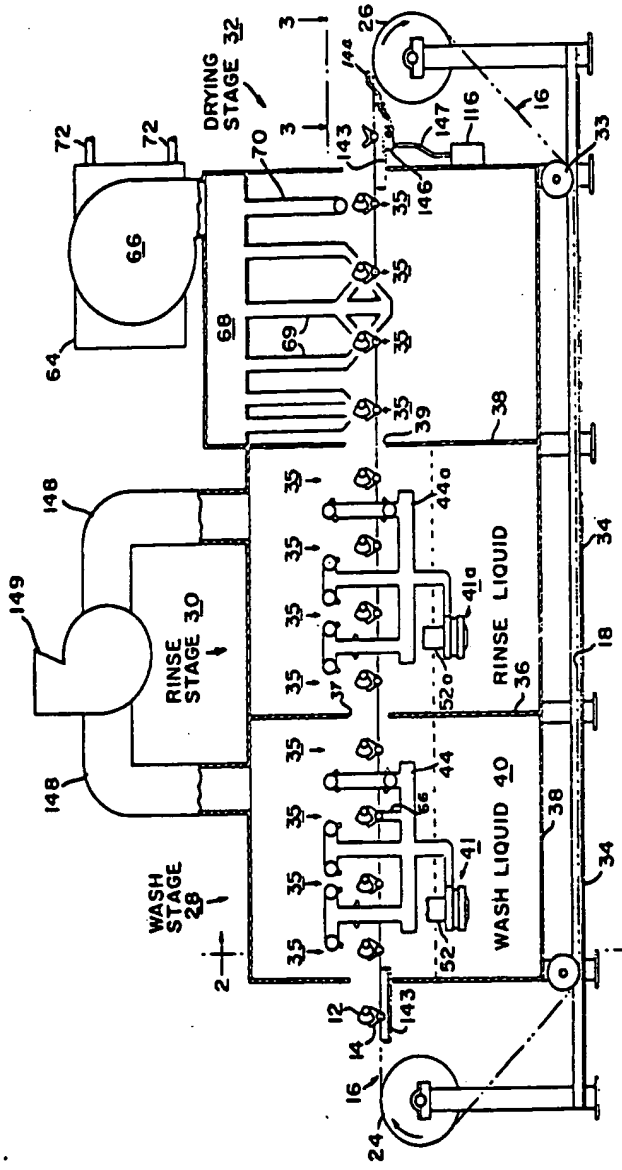
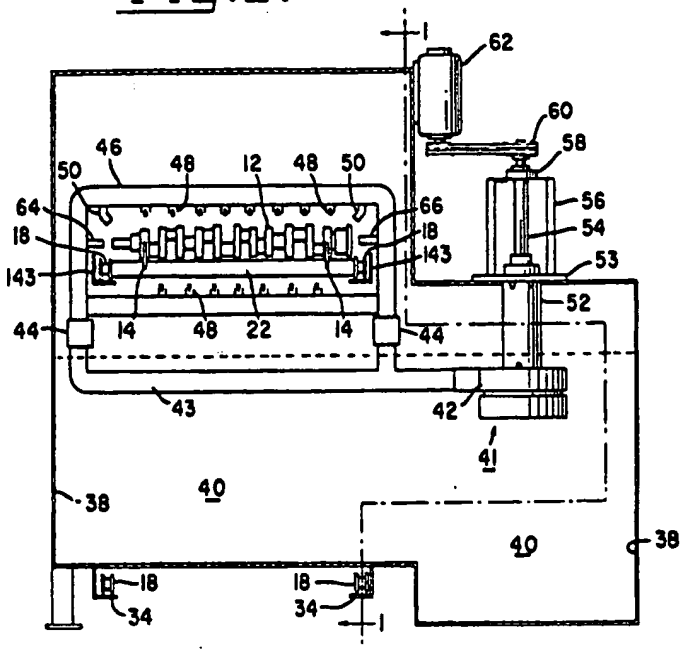

DRYING STAGE 32
RINSE STAGE 30
WASH STAGE 28
RINSE LIQUID
WASH LIQUID 40

Fig. 1.

Fig.2.



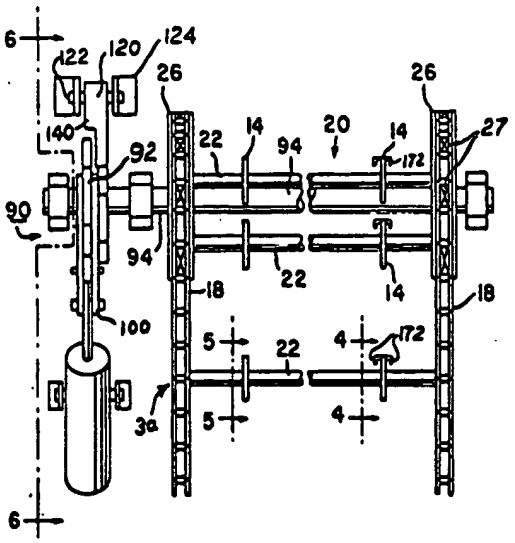


Fig.3.

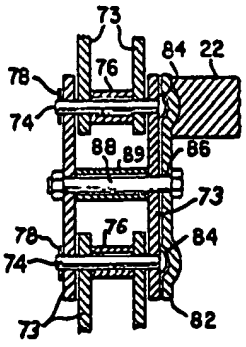


Fig.3a.

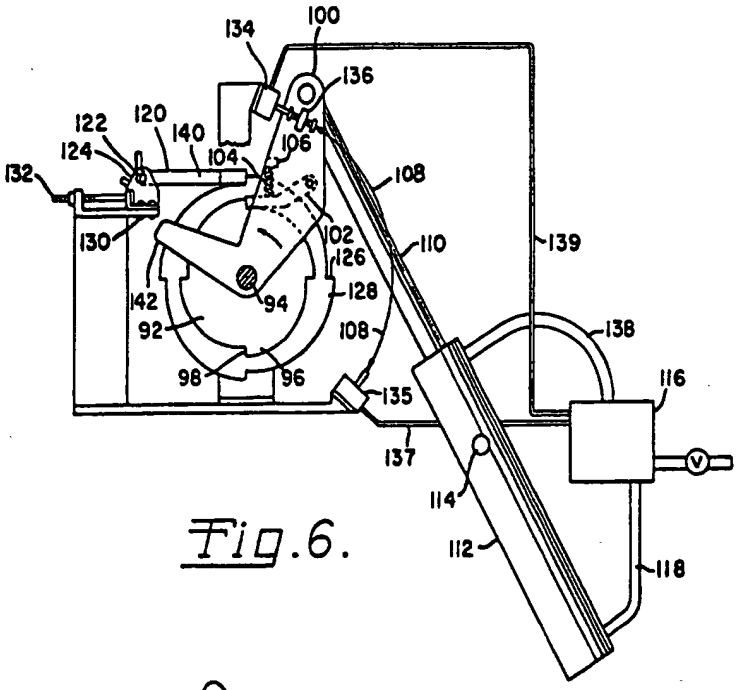


Fig.6.

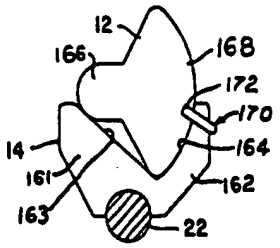


Fig.4.

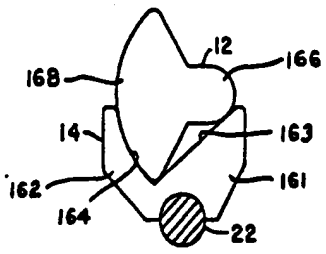


Fig.5.

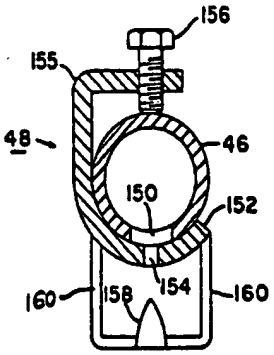


Fig.7.